TECHOLOGY DIGEST

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Identifying Freight Car Maintenance Practices in North America

by Chris Pinney, Tom Guins and *Patrick Little

Summary

Railroads continually seek to improve the predictability of system performance and freight car availability. Transportation Technology Center, Inc. (TTCI) and Harvey Mudd College (HMC) engineering researchers interviewed managers from Class I railroads and private car owners to understand freight car maintenance policies and practices being followed or considered to improve system performance and avoid in-service failures. Of particular interest was whether the requirements of the AAR *Field Manual of the Interchange Rules* were being exceeded. Managers interviewed were asked to describe any innovations they have undertaken that might be useful to other car owners. As a result, the following best practices were identified.

- Use of statistical and analytical tools in maintenance planning
- Integration of new technologies, such as detectors, into maintenance activities
- Improved maintenance management and communications techniques
- Innovative performance measures to reconcile practice to performance
- Improved management of vendor and supplier relationships

North American railroads operate primarily in a corrective maintenance mode. This strategy consists of operating equipment in accordance with maintenance standards, replacing components only when pre-specified conditions are reached. Association of American Railroads (AAR) Interchange Rules are the key maintenance standards used by North American railroads. This strategy of maintaining cars to the Interchange Rules appears to have increased the efficiency of North American railroads since 1980, mainly due to continued improvements in the AAR Interchange Rules and improved car designs.

Under certain operating conditions, corrective maintenance may not be an optimal strategy. More proactive maintenance strategies may improve system performance. The major issues related to proactive strategies are better information about critical components, life-cycle costs, and understanding how components may be timed for replacement along with other key components. TTCI and HMC plan to develop a computer simulation model to support analysis of such maintenance actions and maintenance policies. The information learned from the interviews with maintenance managers will develop the policies modeled, assist in selecting car types, components, and technologies to be analyzed, and guide the development of performance measures to be reported by the model.

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Suggested Distribution:
- ❑ Car Department
- ❑ Planning & Analysis
- ❑ AAR Billing Office
- ❑ Safety

Work performed by TTCI Transportation Technology Center, Inc.
a subsidiary of the Association of American Railroads

INTRODUCTION

TTCI and Harvey Mudd College researchers interviewed managers from Class I railroads and private car owners to understand maintenance policies and practices being followed or considered. Questions included size and usage of fleets, maintenance policies being followed, performance measures used, information and organizational structures, and the impact of new technologies on the maintenance policies and practices of the companies. One particular question asked was whether the requirements of the AAR *Field Manual* were being exceeded. Interviewees were asked to describe any innovations they have undertaken that might be useful to other car owners.

This *Technology Digest* describes the background of freight car maintenance in North America and reports on the results of the structured interviews with maintenance managers.

BACKGROUND

The North American freight car fleet consists of approximately 1.6 million cars, the ownership of which is shown in Exhibit 1. Shippers and equipment leasing companies now own nearly 64 percent of the freight cars. Railroads and private car owners are estimated to spend approximately $1.5 billion annually on freight car repair and maintenance activities. For example, repair and maintenance for U.S. operated Class I railroads was approximately $564 million in 2000 with just over 19 percent ownership in the North American fleet.[1] In addition, another $391 million was billed through the AAR's Car Repair Billing (CRB) system. These traceable costs are independent of the expenditures incurred by private car owners and non U.S. railroads in North America outside of the CRB system for repairs to other railroads' cars and privately-owned; i.e., private car owner, equipment.

The pattern of expenditure by car types can also be estimated using AAR data. Exhibit 2 shows the expenditure by car types per 1000 miles and percent of total spending by car type for U.S. Class I railroads. As shown in Exhibit 2, the cars which incur the highest costs to operate do not necessarily constitute the highest fleet costs. Fleet level costs are a function of fleet size, intensity of use, and characteristics of the equipment. Exhibit 2 shows hopper and gondola cars used to haul coal; they have the highest fleet maintenance costs.

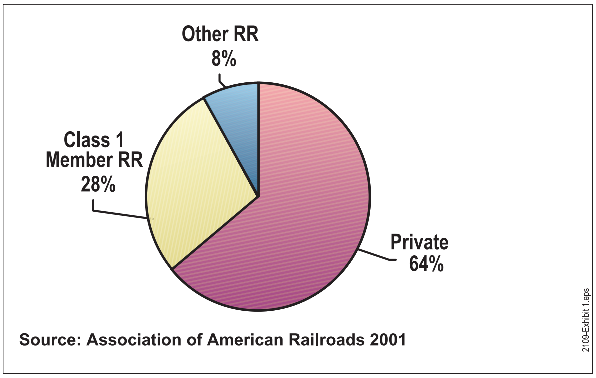

Exhibit 1. Freight Car Ownership

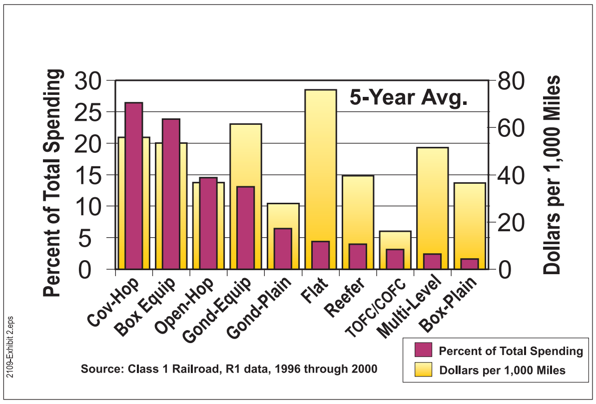

Exhibit 2. Repair and Maintenance by Car Type

Exhibit 3 shows AAR car repair billings by component or subsystem. Because this includes running repairs made to vehicles operating in Interchange service, it provides a benchmark for the railroad industry's repair and maintenance spending by component. However, it may understate certain expenditures for which the car is typically "home shopped," including doors, hatch covers, and specialty equipment, which may make the car unsuitable for use, but not unsafe to transport. Exhibit 3 does, however, show the expenditure areas that are most strongly affected by AAR Interchange Rules.

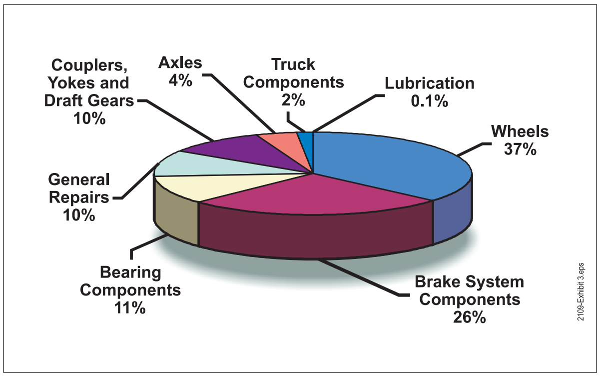

Exhibit 3. 2000 Car Repair Billing Statistical Report

Maintenance expenditures and reliability change over the life of a car. Exhibit 4 shows the results of a study performed for a private car owner. Both costs and reliability follow a similar but inverted shape. In the initial period of ownership, there are costs and service problems typically found in the shakedown phase of new

TTCI = Transportation Technology Center, Inc.; AAR = Association of American Railroads equipment. The cars then enter a period of high reliability at modest costs. Finally, as the equipment ages, both costs and reliability deteriorate. These results will not surprise experienced managers who have looked for ways to counteract the effects of aging in vehicles. They do, however, raise interesting questions regarding equipment acquisition: Can the high costs and lower reliability of early stages be avoided? Should car owners follow the same policy for all cars in a fleet without consideration of the effects of age?

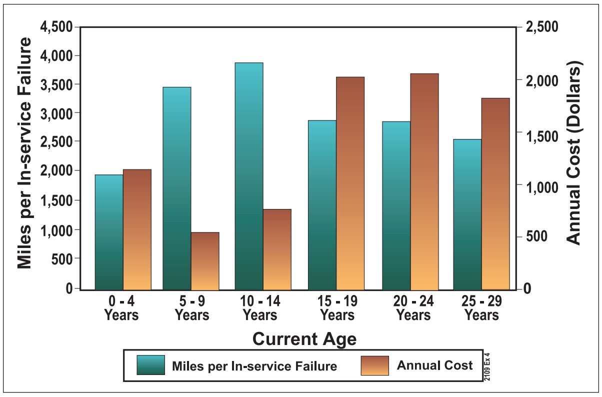

Exhibit 4. Results of a Study Performed for a Private Car Owner

INNOVATIONS AND BEST PRACTICES

Use of Statistical and Analytic Techniques

Several companies use Weibull analysis to support maintenance activities. Weibull analysis is the fitting of failure data to the Weibull distribution to determine the nature and duration of a component's lifetime. Because of the properties of this distribution, Weibull analysis can determine if a component is likely to wear out at a particular time or fail in an unpredictable manner. In addition, the analysis can determine if a component is a good candidate for planned maintenance. One company calculates Weibull parameters of key components and uses these results with vendors to improve component quality. Another company uses Weibull analysis to determine the mileage threshold for replacing wheelsets for its refrigerated boxcar fleet. Unplanned bearing failures were creating a serious customer service problem, so the company used the analysis to determine that wheelsets could be replaced at approximately 270,000 miles under conditions of the company's choosing.

Another company uses Pareto analysis to identify components that are hurting fleet performance, and uses root-cause analysis to determine the reasons for the poor performance. Pareto analysis is the collecting and ranking of events in terms of their frequency or severity. Once the events have been ranked, managers assess whether the problems can be addressed. The company meets with shop personnel and vendors to determine why components are being replaced, finds the underlying cause, and takes action where appropriate.

Use of New Technologies and Techniques

All major railroads use wayside detection technologies. These range from hot bearing and dragging equipment detectors to emerging technologies such as truck performance devices. Full integration of detectors into the overall maintenance system is still at an early stage. A number of the railroads are using Wheel Impact Load Detectors (WILD) to find seriously defective wheels and to predict and plan for future maintenance actions. One railroad recently inaugurated a fully integrated system in which a wheelset that exceeds a threshold (after adjustment for loaded/empty status and for speed) is automatically triggered as a "shop when empty" car for wheel inspection and replacement. The intent is to give the railroad control over the time and place of the replacement while avoiding future events along the right of way. By fully automating the system, the railroad maintains strict control over the thresholds in a way that is transparent to field forces.

In an innovative practice that addresses issues of reliability and system safety, one of the Class I railroads performs an ultrasound inspection on every turned wheelset before restoring it to service.

Management and Maintenance Policy Activities

There have been industrywide changes in recent years that drive almost all other innovations in maintenance management. The most significant change is in how the mechanical department relates to other parts of the railroad. Almost all managers interviewed indicated that they considered fleet management and marketing groups as internal customers and shippers as external customers. The focus of maintenance has shifted from telling customers what is available to asking what is needed. This change in relationships has had a profound effect on all aspects of maintenance decision-making.

Managers can have a great effect on behavior by the selection and use of performance-measures. Correctly chosen, performance-measures reveal the organization's goals and objectives, track the progress of their goals, and encourage application of appropriate resources to achieve their goals. Managers at one company identify key performance indicators (KPI) designed to tie maintenance actions to needs of car users. For strategically important sub-fleets, managers use measures such as miles per in-service failure, availability of cars versus customer demand for cars, and time in shop for planned maintenance activities. Another company with free-running cars monitors train stop events and car set outs. They also measure car days out of service for scheduled or unscheduled maintenance.

In a noteworthy innovation, a Class I railroad has changed its measure of out-of-service time to begin when the car is tagged out-of-service rather than when the car is placed on the repair track. The company also considers out-of-service time as a performance measure for both the operating and mechanical departments. This has encouraged cooperation with the mechanical department implementing more in-yard repairs and the transportation department offering more timely switching of the repair track. This has led to a reduction in average out-of-service time for defective loaded cars to less than 24 hours at a key yard.

Another useful practice is improved planning within the mechanical department. One railroad carefully examined why several maintenance initiatives were unsuccessful. It learned that shop personnel had not been adequately consulted during the planning stages, information systems support for the new practices were inappropriate, and performance measures had not been changed to conform to the new practices. They now use *Car Repair Process Teams* to develop and implement changes in maintenance policies. At another railroad, when a series of cars is scheduled for a major program, workers bring one of the cars into the shop to examine. A meeting is held with maintenance planners and shop personnel to determine if changes to the program are appropriate.

All of the railroads indicated that they have severely reduced mileage-based planned maintenance programs. Instead, cars are maintained according to the AAR *Field Manual*, and set to Heavy Bad Order (HBO) status, if required repairs exceed a threshold (usually measured in terms of labor-hours). At one railroad, the HBO decision varies by car type and market demand. This railroad also uses economic and car repair histories to decide which cars to include in overhaul programs. Each car is evaluated in terms of the expected costs to fix defects and to bring non-defective components up to nearly new condition. A car with relatively new running gear, for example, may be selected ahead of a less worn car with older equipment.

Most private car owners perform scheduled maintenance for key components, depending on the nature of the commodities hauled and the intensity of use. One very high mileage fleet, for example, is scheduled for major maintenance activities every 900,000 miles, which matches the current lifetime of trucks. The owner monitors the condition of trucks and adjusts maintenance cycles if the wear life of trucks increases. A company which operates unit trains plans its cycles such that one trainset is always undergoing planned maintenance. They then adjust their activities to conform to the interval which results.

Some car owners allow shops to replace components prior to the AAR *Field Manual* maintenance limits; for example, removing wheels within 1/16 inch of the replacement limits. Removal of unfailed components is part of a larger policy of opportunistic maintenance that is being adopted in the rail industry. Opportunistic maintenance is based on the idea that a maintenance event is a chance to replace other components that are near failure limits.

Relationships with Suppliers and Vendors

Some managers are particularly innovative in dealing with vendors and suppliers. One company inspects the lines of car builders prior to setting specifications for new cars, both to incorporate innovations and to exclude construction techniques that are inappropriate for their planned uses. This company also inspects cars during construction and rejects new cars, which fail initial inspections. They believe this approach has reduced failures during the early life of cars.

An area of interest is warranties on parts and services. Some companies expressed frustration with developing enforceable warranties for critical components. One company replaced bolsters on more than 800 cars, which did not perform in accordance with specifications. Enforceable warranties require identification and monitoring of the component, control over maintenance and a long-term relationship with the vendor. Warranties for routine parts will require unique identifiers to match the part to a car.

Reference

1. Class I Railroads Annual Report, Dec. 31, 2000.

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